phx ModelCenter® INTERNATIONAL
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Collaborative Design at DLR in Distributed and Co-Located Environments

Arne Bachmann, Pier Davide Ciampa, Evelina Dineva, Erwin Moerland, Björn Nagel, Till Pfeiffer, Thomas Zill

DLR

Presentation Outline

- **Introduction**
- Technical collaboration
- Human collaboration
- Conclusion

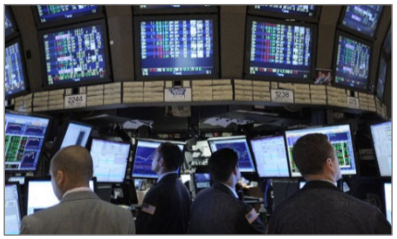
Aircraft Design

Potential Solutions For Future Air Transport

DEMAND

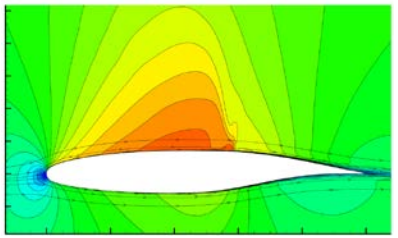
Mobility

Environment

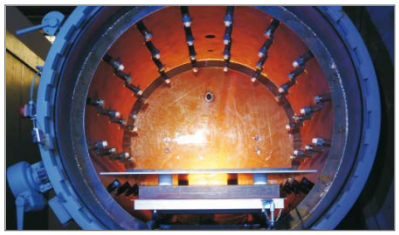


Economy

Propulsion



Aerodynamics



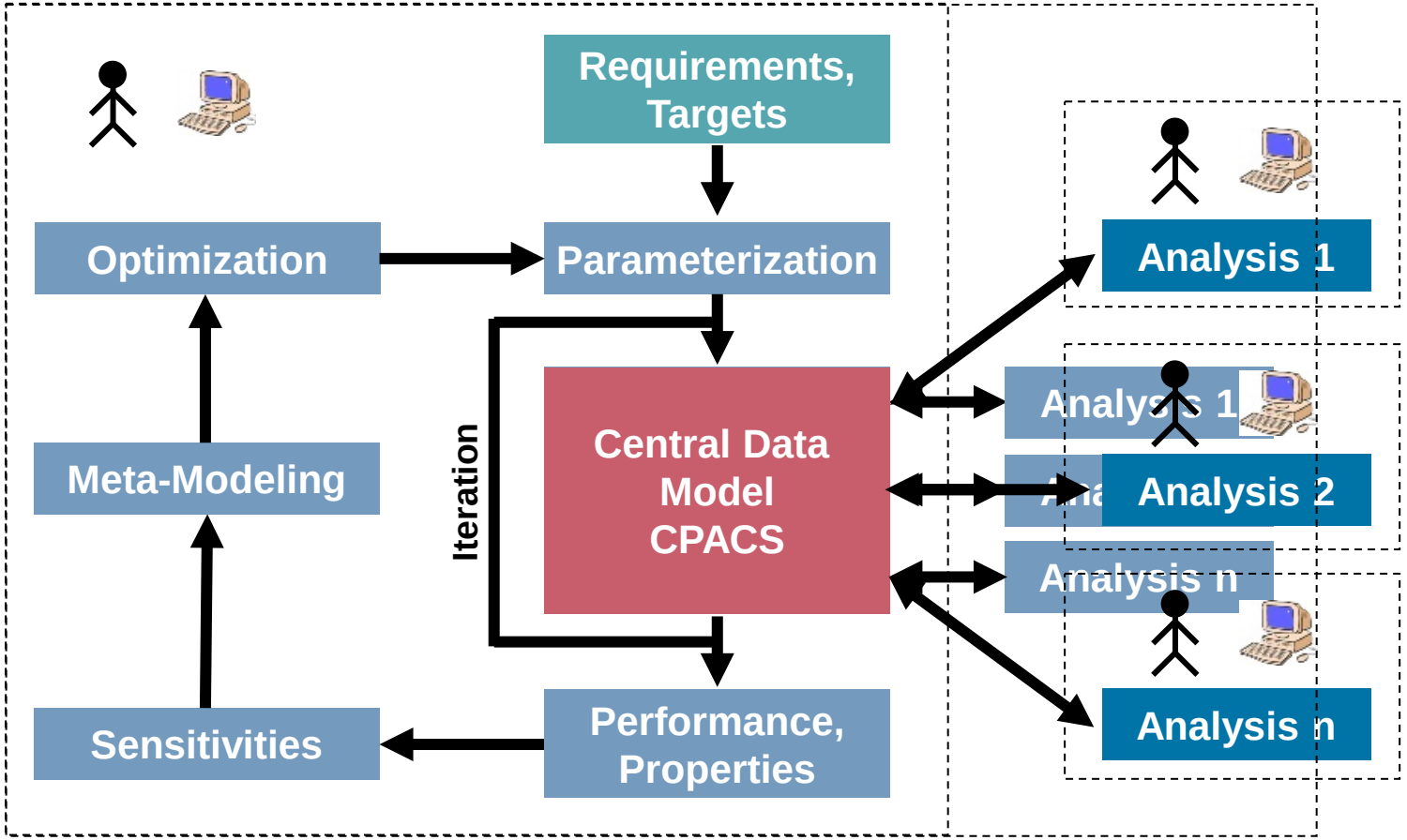
Structures

TECHNOLOGIES

DLR

Collaborative Aircraft Design

Merging Competences

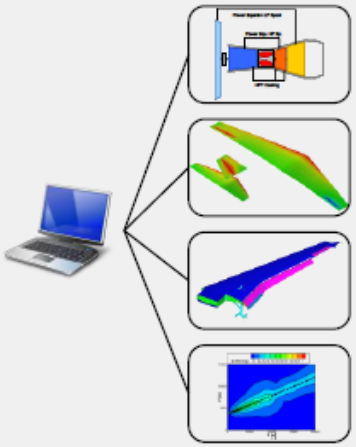


Multidisciplinary Design & Optimisation

Definition introduced by Prof. I. Kroo and Prof. J.J. Alonso, Stanford University

1st generation

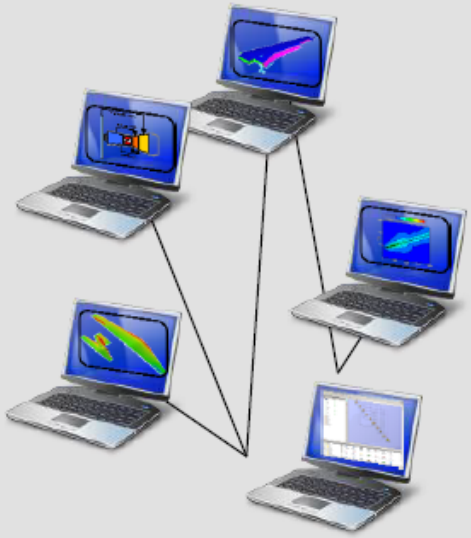
analysis-based design computations



- optimisation algorithms
- approximation techniques

2nd generation

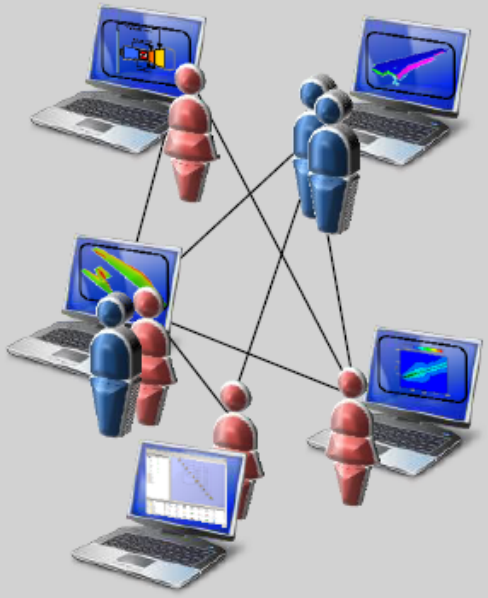
Workflow management



- networked computing
- # disciplinary interfaces ↑

3rd generation

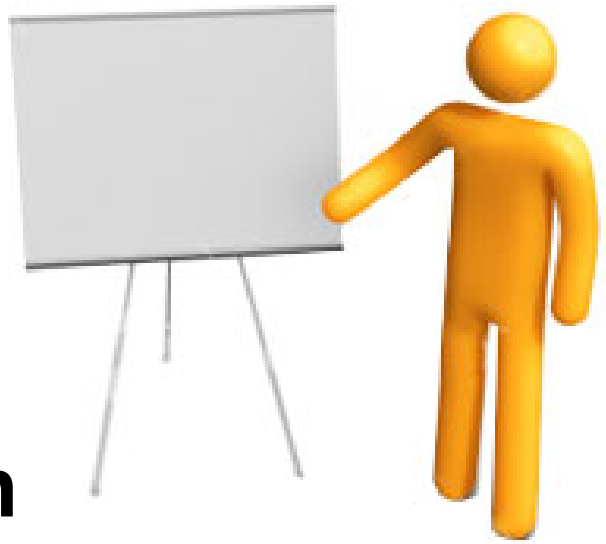
Optimisation assisted design in teams



- management of knowledge
- collaboration of engineers and tools

DLR

Presentation Outline



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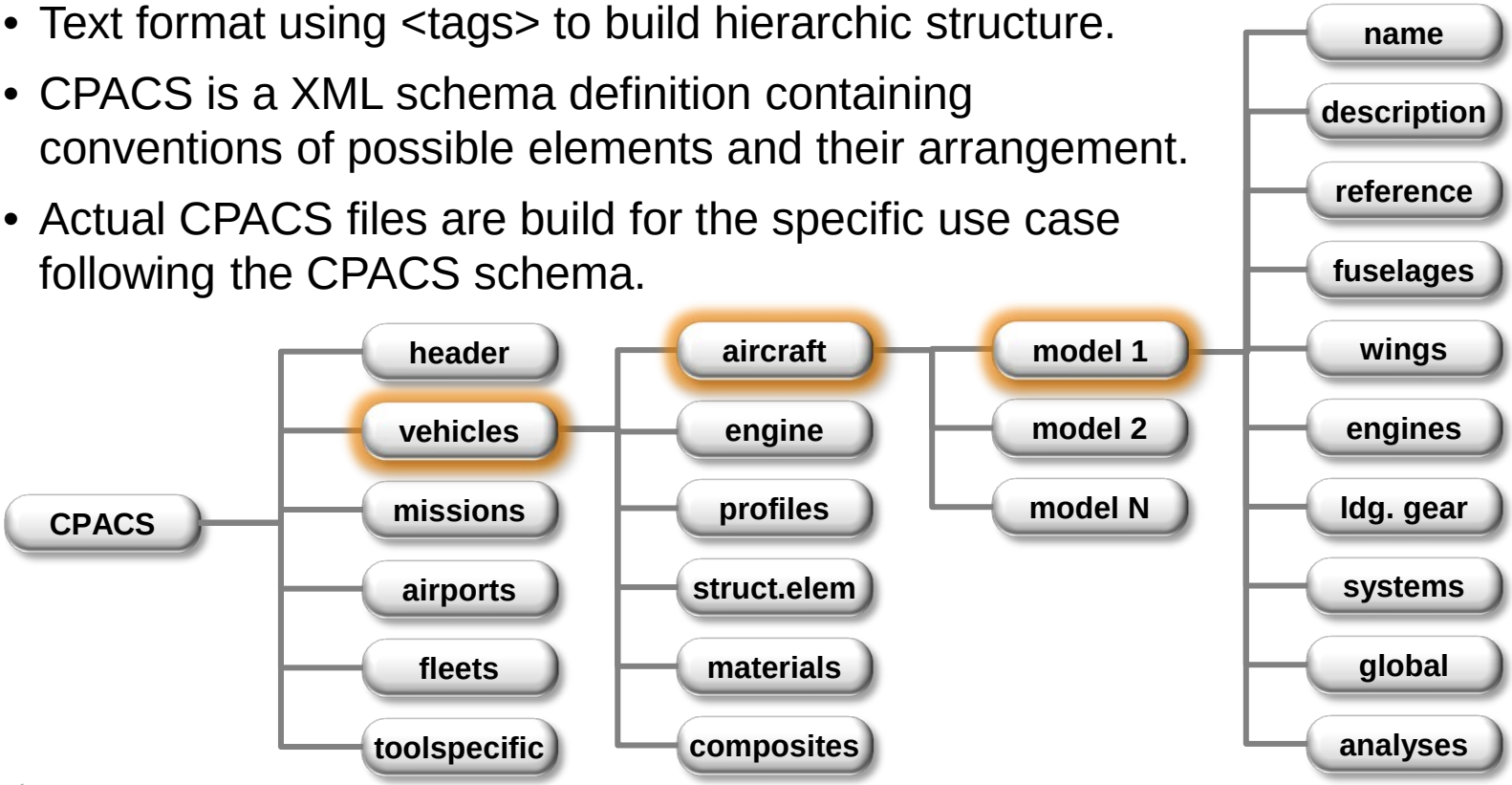
CPACS Data Model

Common Parametric Aircraft Configuration Scheme

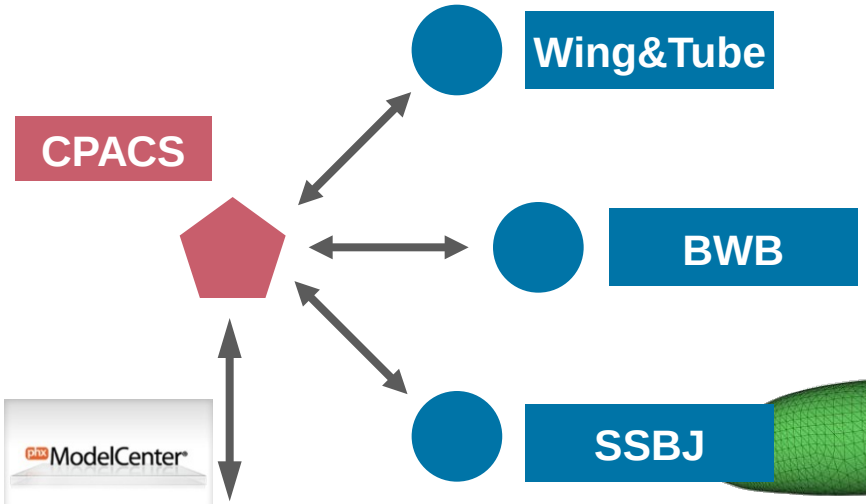
- Extensible Markup Language XML: Open W3C standard.
- Text format using <tags> to build hierarchic structure.
- CPACS is a XML schema definition containing conventions of possible elements and their arrangement.
- Actual CPACS files are build for the specific use case following the CPACS schema.

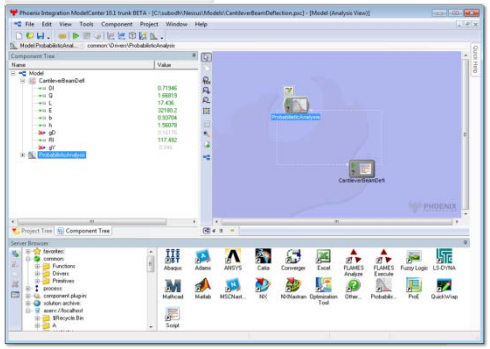


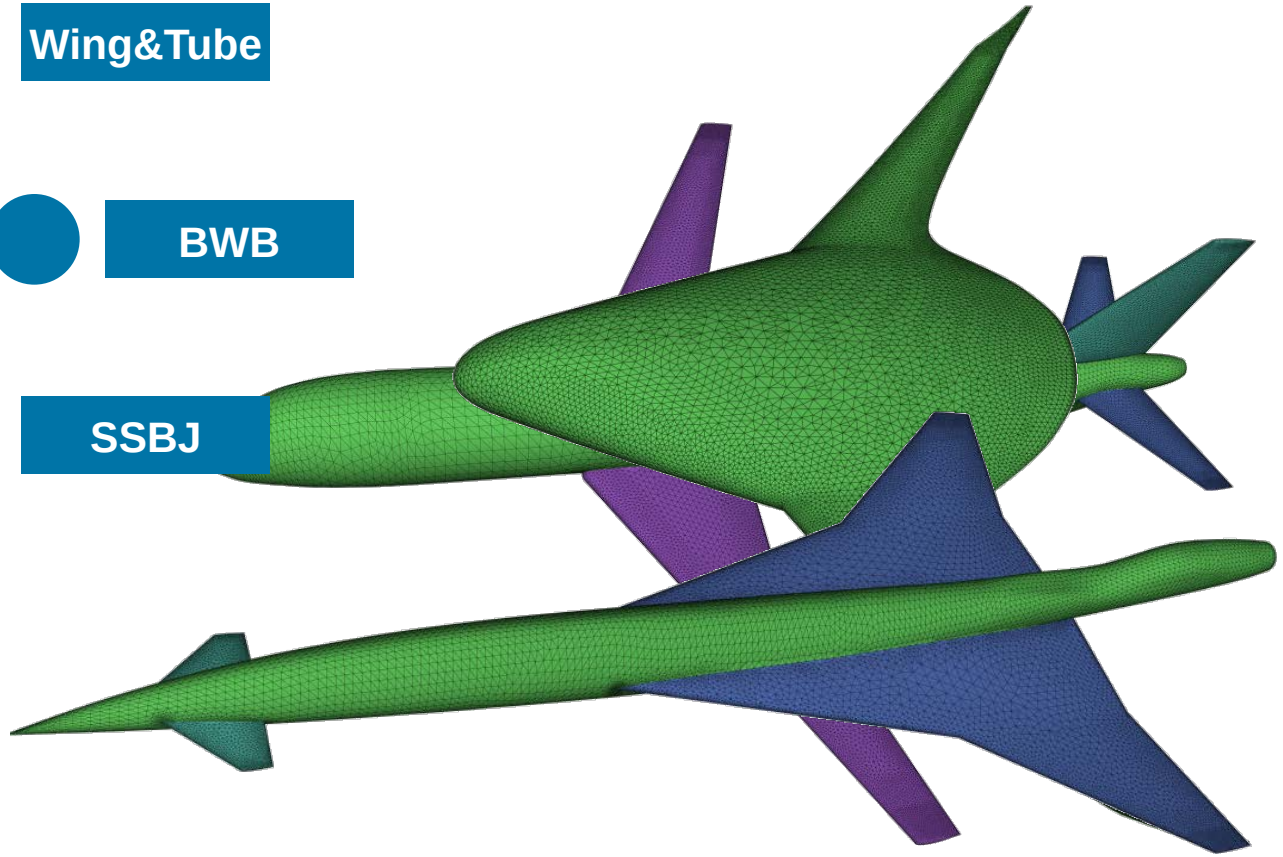
C. M. Liersch, et.Al., A distributed toolbox for multidisciplinary preliminary aircraft design, *CEAS Aeronautical Journal (2011) 2:57–68*

CPACS Experiences

Wide & Extensible Design Space



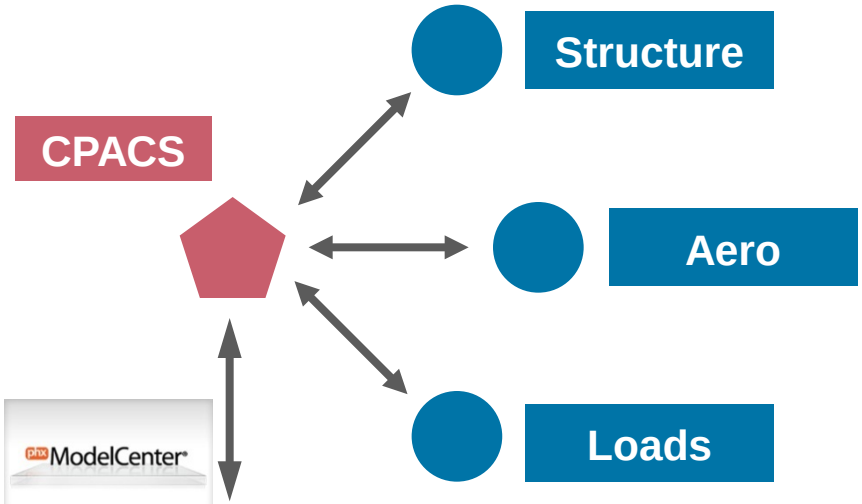


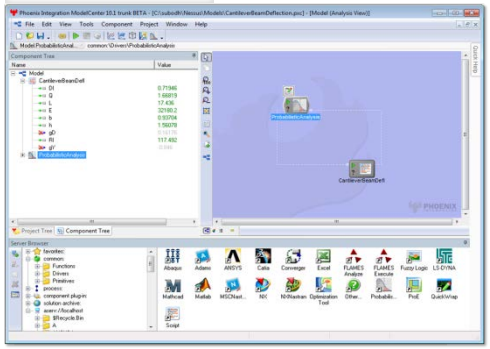


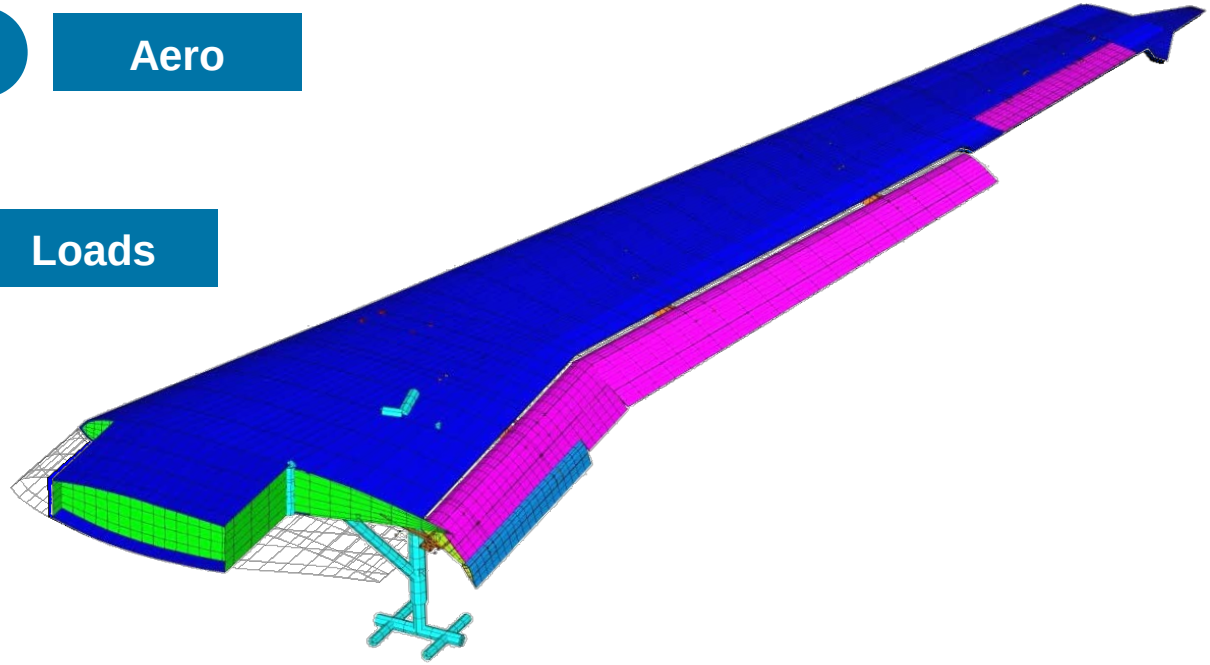
P. D. Ciampa, et.Al.l, CST parametrization for unconventional aircraft design optimization, *International Council of the Aerospace Sciences (ICAS) 2010, Nice, France*

CPACS Experiences

Multidisciplinary Modelling



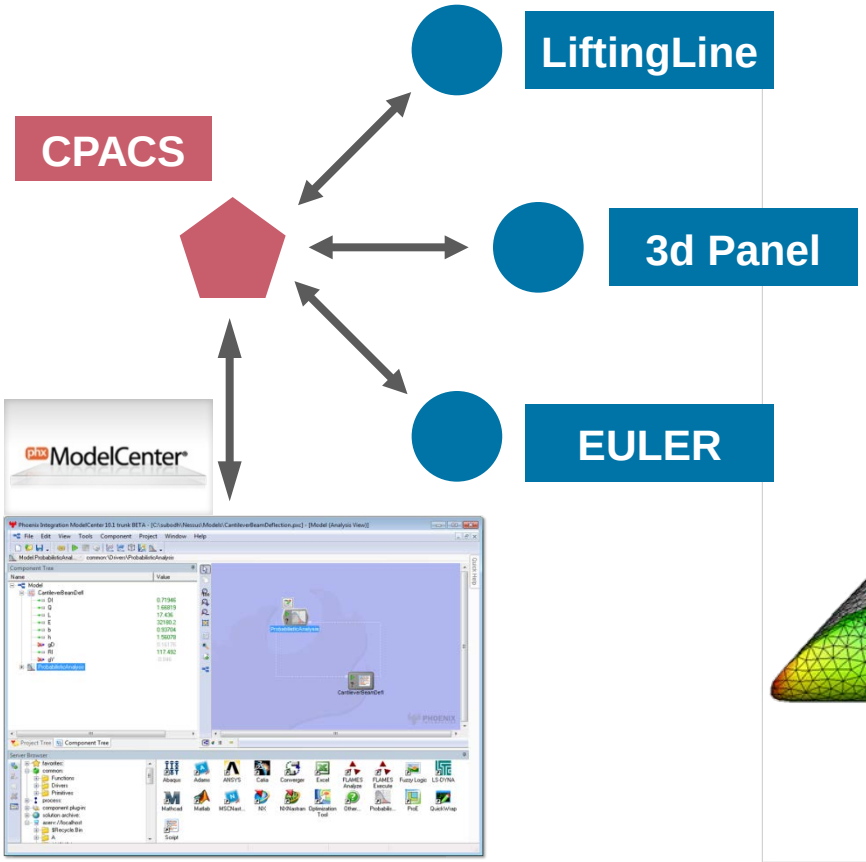


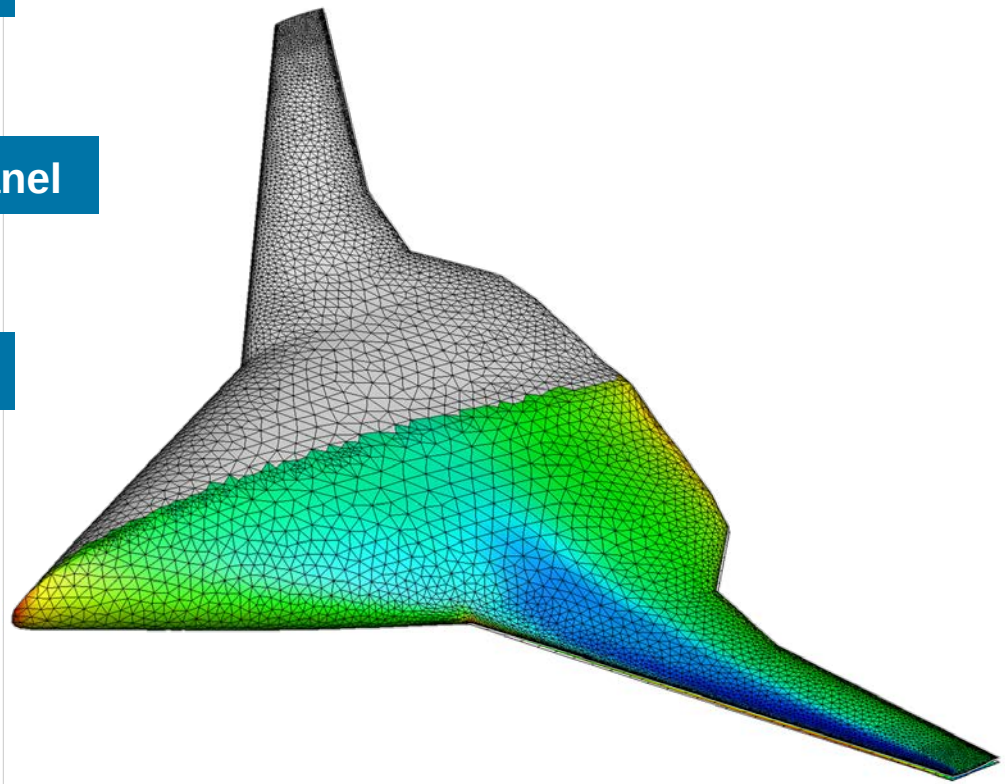


F. Dorbath, et.Al., A knowledge based approach for extended physics-based wing mass estimation in early design stages,, CAS 2012-1.1.1

CPACS Experiences

Multi-Fidelity Modelling

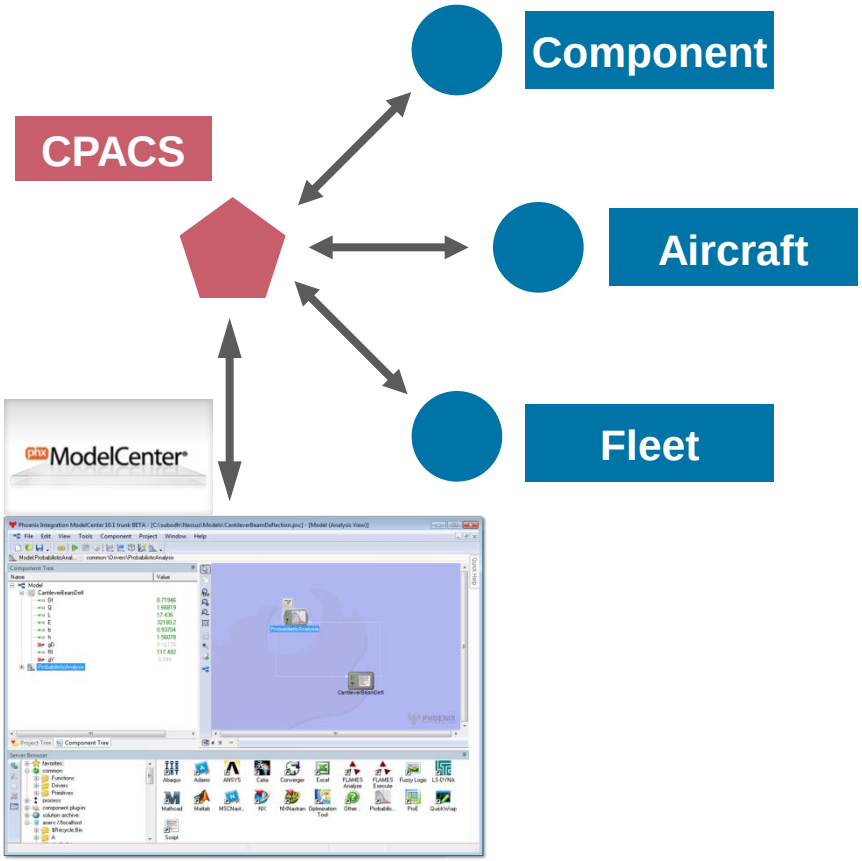


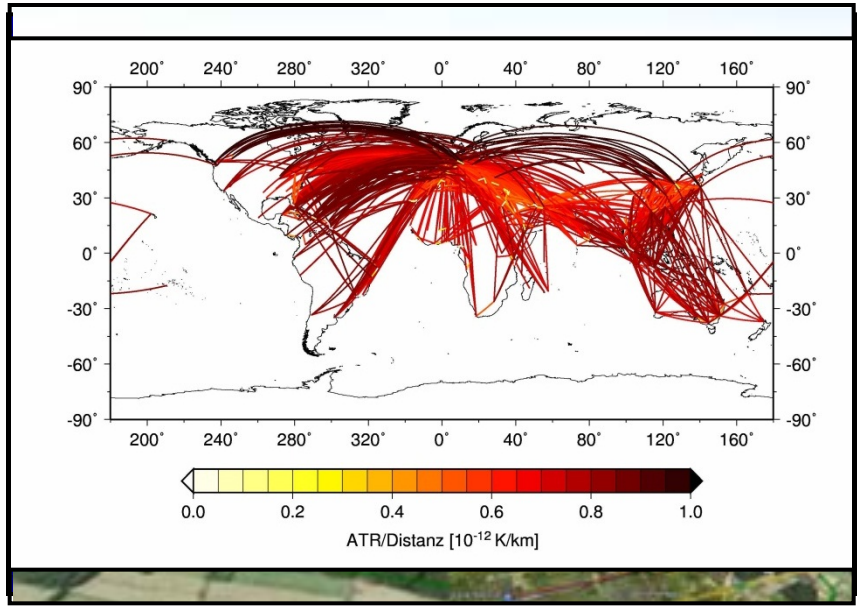


T. Pfeiffer, et.Al., Implementation of a Heterogeneous, Variable-Fidelity Framework for Flight Mechanics Analysis in Preliminary Aircraft Design, *German Aeronautics and Space Congress, DLRK, 2011,*

CPACS Experiences

Multi-Scale Modelling

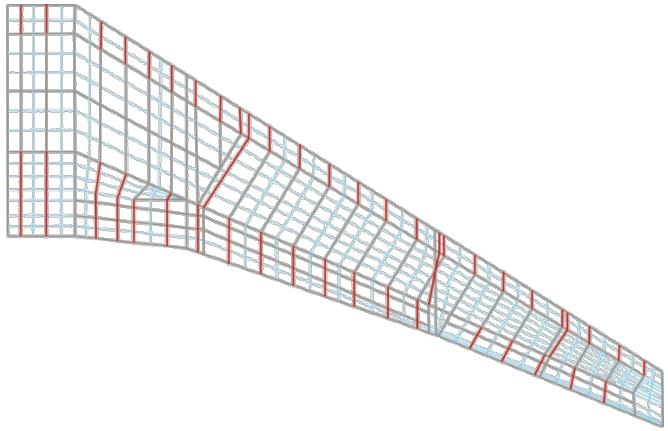


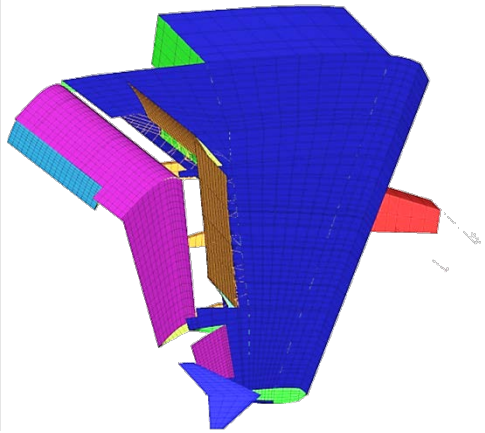


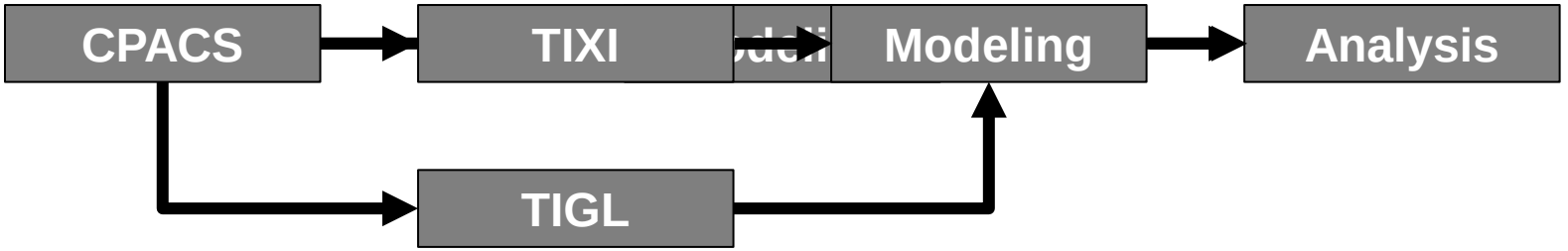
A. Koch, et.al.l, Climate impact assessment of varying cruise flight altitudes applying the CATS simulation approach, 3rd International Conference of the European Aerospace Societies, (CEAS), Venice, Italy (2011).

Building Disciplinary Models Based On CPACS

Different Ways Of Accessing CPACS







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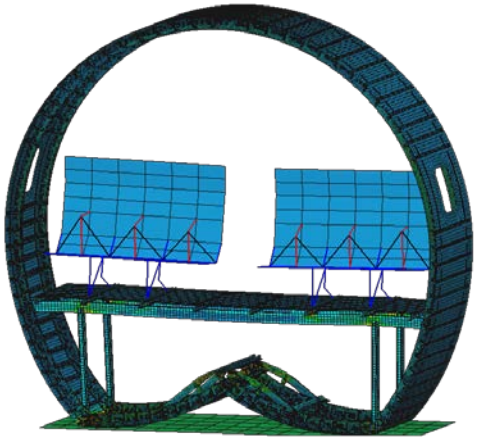
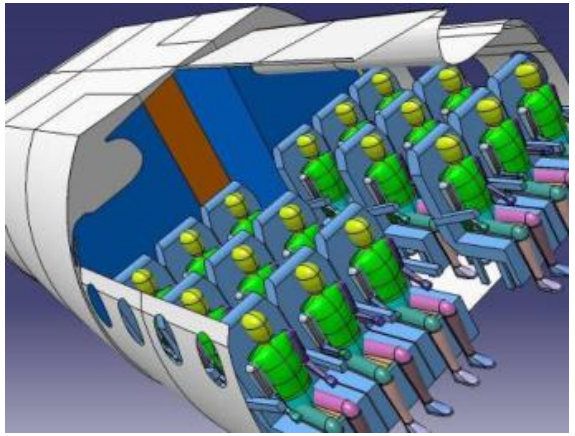
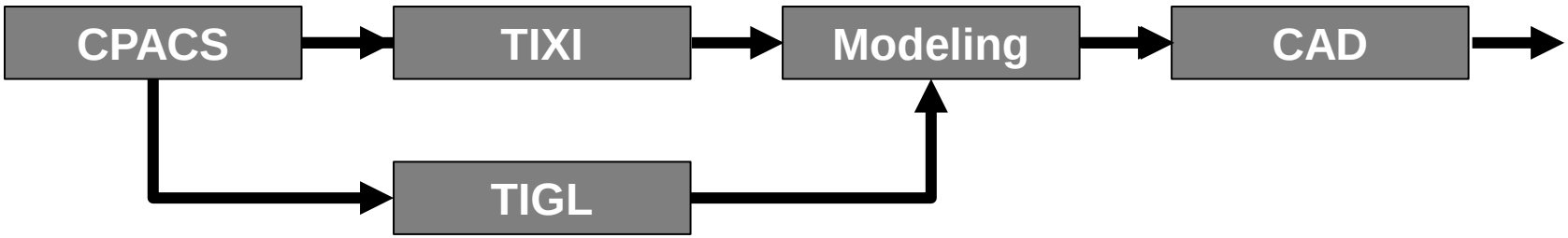
Building Disciplinary Models Based On CPACS

Different Ways Of Accessing CPACS







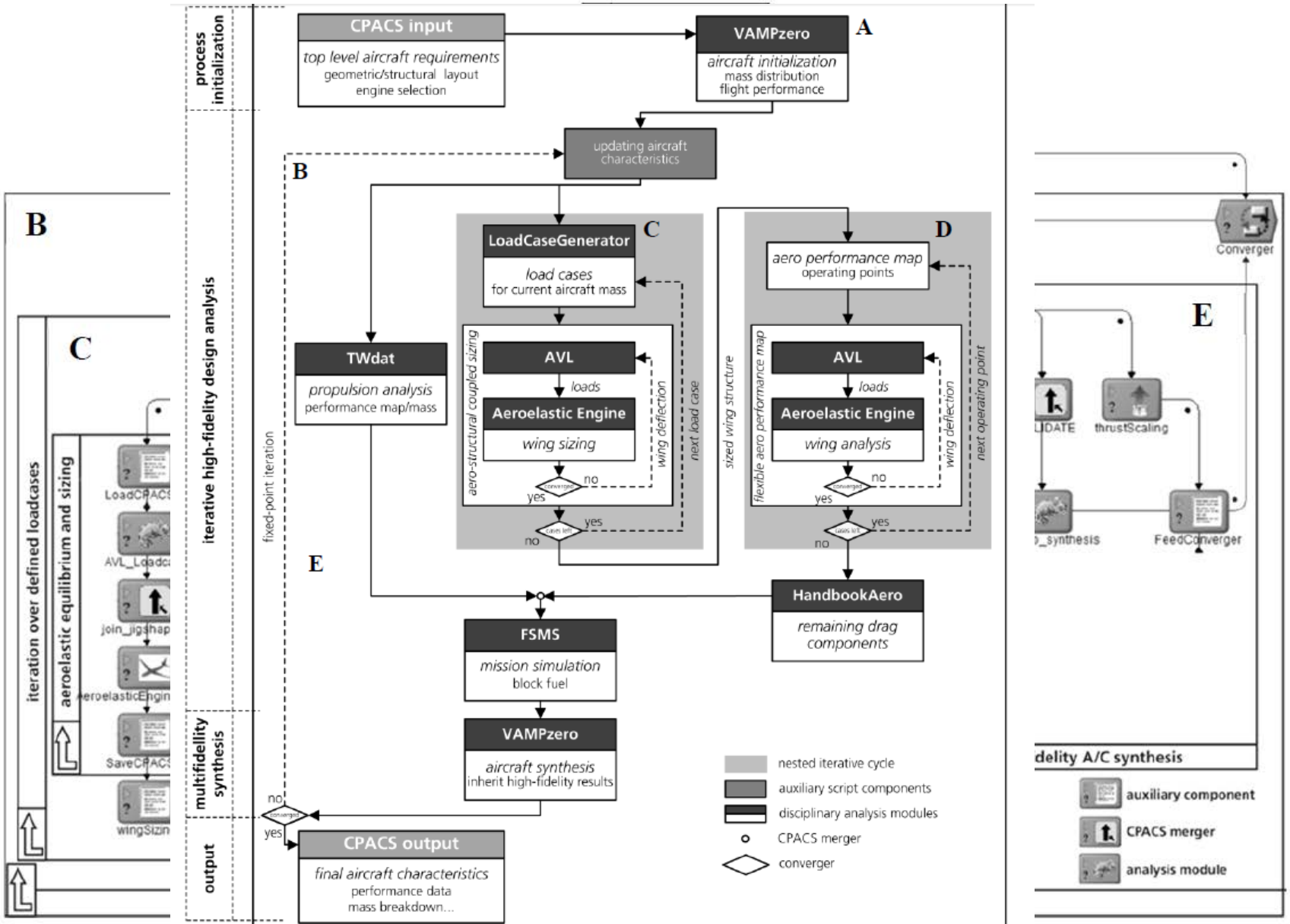
J. Fuchte, et.Al., Rapid Model Creation for Cabin CFD Simulations, *Aircraft Systems Technology, AST, Hamburg, Germany, 2011*

- Compatibility releases for ModelCenter from version 7.1 to 8,9 and 10
- Compatibility releases for Analysis Server from version 5.12 to 6 and 7
  - Windows 7 compatibility
  - 2011 last full version of toolsuite
  - 2012 last bug fix
- GUI components for remote server inspection, log introspection and more
- Centralized config file with server information replaced by proxy approach
- Replaced string variables by raw file variables
  - Zipped and not saved with workflow
- All result plots and satellite data transferred in compressed variable

Example: Distributed workflow built with CPACS + ModelCenter: aerodynamic-structural coupling

- Mode of operation: Use ModelCenter mainly as
  - workflow driver and communication/transport layer
  - for optimization (convergers)
  - assuming a blackbox approach behind generalized code wrappers
  - for post-processing (response surface, surrogate models)

- Goal: Extending an existing multidisciplinary workflow for aircraft design
  - Use better physics-based methods for estimation of aerodynamics
  - Still in predesign phase, runtime only several hours
  - Results differ significantly from previous results that neglect the interdisciplinary coupling and snowball effects


process initialization
iterative high-fidelity design analysis
multifidelity synthesis
output
fixed-point iteration
CPACS input
top level aircraft requirements
geometric/structural layout
engine selection
VAMPzero
aircraft initialization
mass distribution
flight performance
A
updating aircraft characteristics
B
LoadCaseGenerator
load cases
for current aircraft mass
C
TWdat
propulsion analysis
performance map/mass
aero-structural coupled sizing
AVL
loads
Aeroelastic Engine
wing sizing
wing deflection
next load case
converged
no
yes
cases left
yes
no
sized wing structure
D
aero performance map
operating points
flexible aero performance map
AVL
loads
Aeroelastic Engine
wing analysis
wing deflection
next operating point
converged
no
yes
cases left
yes
no
E
HandbookAero
remaining drag components
FSMS
mission simulation
block fuel
VAMPzero
aircraft synthesis
inherit high-fidelity results
converged
no
yes
CPACS output
final aircraft characteristics
performance data
mass breakdown...
nested iterative cycle
auxiliary script components
disciplinary analysis modules
CPACS merger
converger
B
C
iteration over defined loadcases
aeroelastic equilibrium and sizing
LoadCPACS
AVL_Loadc
join_jigshap
eroelasticEngin
SaveCPACS
wingSizin
E
Converger
LIDATE
thrustScaling
_synthesis
FeedConverger
delity A/C synthesis
auxiliary component
CPACS merger
analysis module

Our wishes for phx ModelCenter®

- No more new features required
- Single most important feature wanted: Stability
  - Random crashes, not always reproducible
  - Runtimes over days
  - Resilience over server outages – don‘t stop the world
- Saveable workflow files cannot be reloaded (memory issues)
  - Could be solved by storing big variable contents in satellite files

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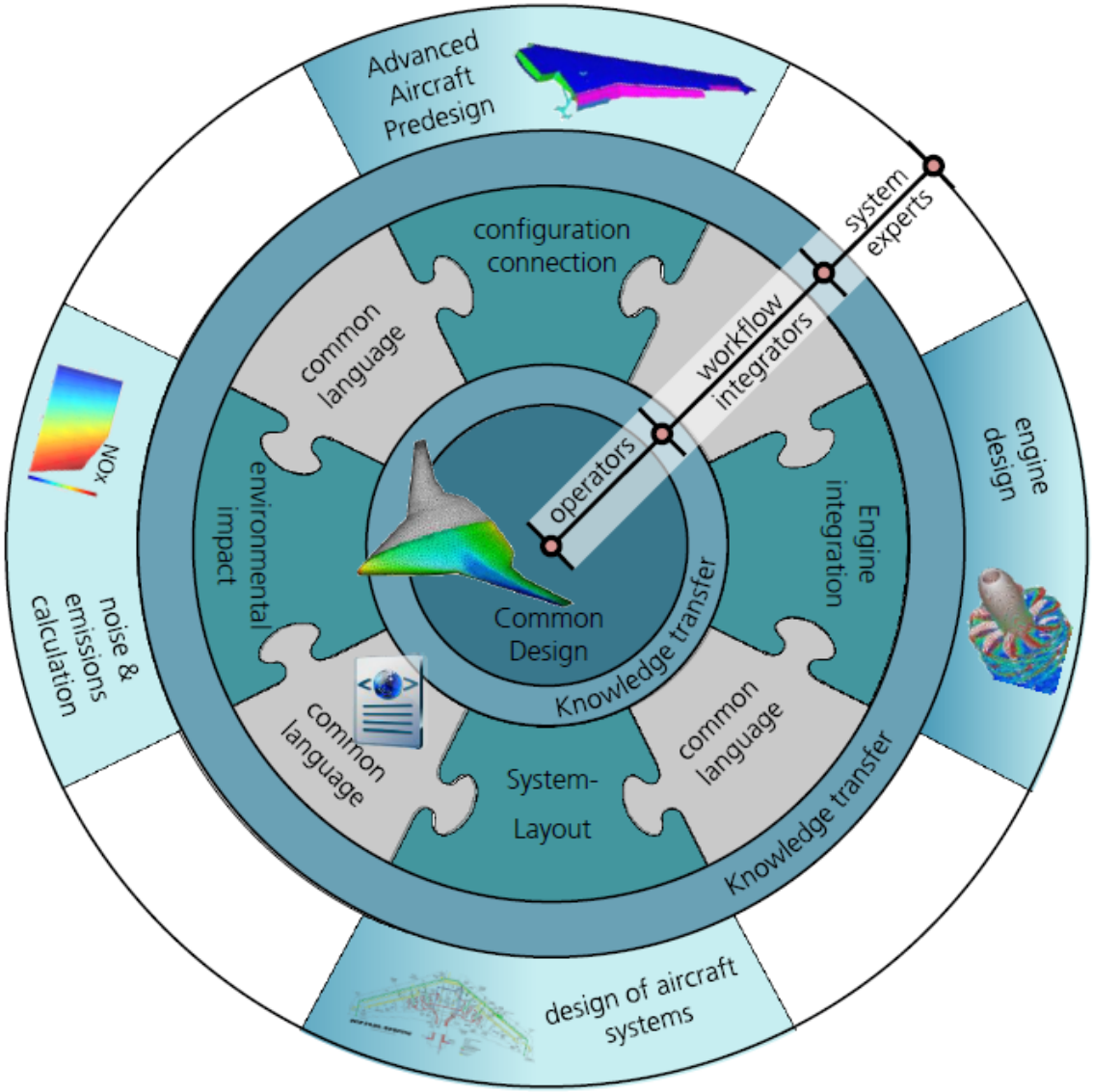
New Challenges

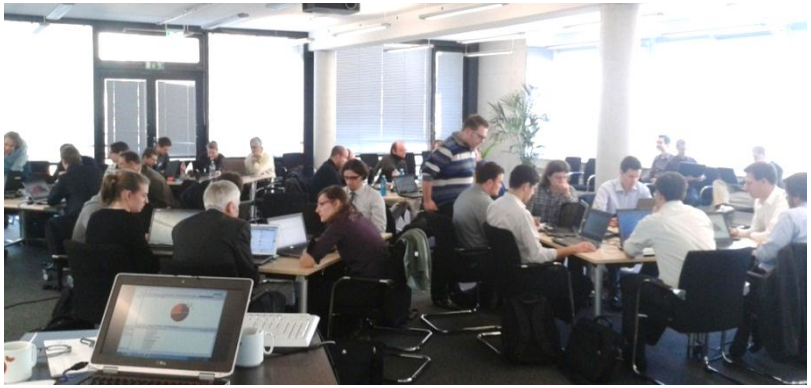
„Having Tools“ does not mean „Having Skills“


Advanced Aircraft Predesign
system experts
engine design
design of aircraft systems
noise & emissions calculation
NOx
configuration connection
common language
workflow integrators
operators
environmental impact
Engine integration
Common Design
Knowledge transfer
common language
System-Layout
common language
Knowledge transfer

Challenges in Collaboration

3rd Generation MDO

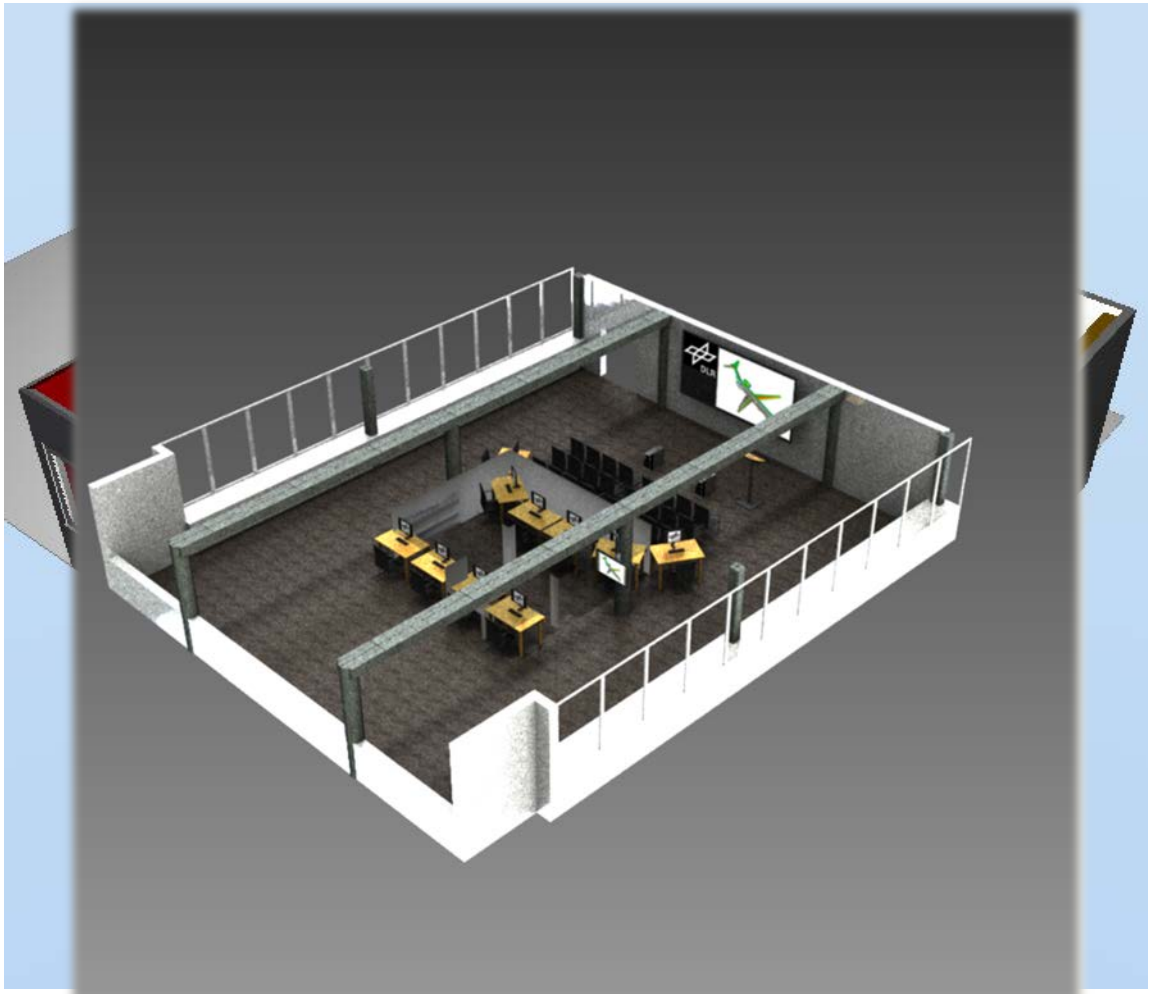
VAMP Design Camp



CPACS Symposium (IDL)

- Debugging
- Comprehension
- Heterogeneous team of specialists
- Collaboration
- Management
- Communication
- Handling knowledge
- → 3rd Generation MDO
- Finding partners with 2nd Generation MDO expertise
- CPACS Symposium

The Integrated Design Laboratory (IDL)

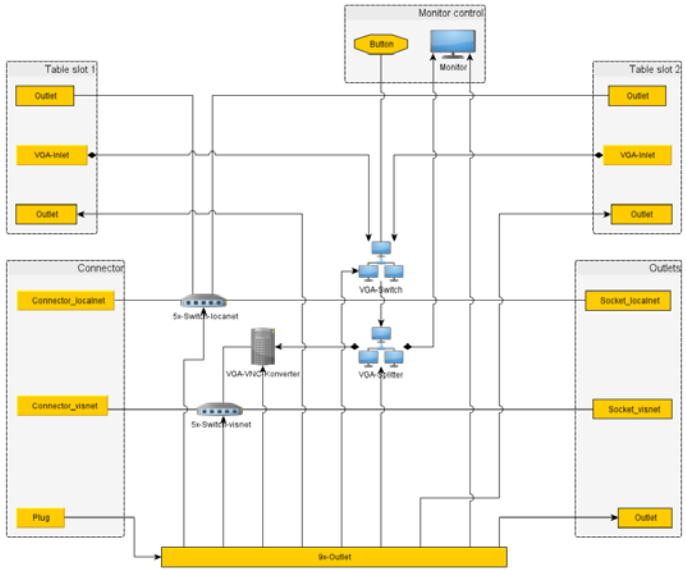


The Integrated Design Laboratory (IDL)

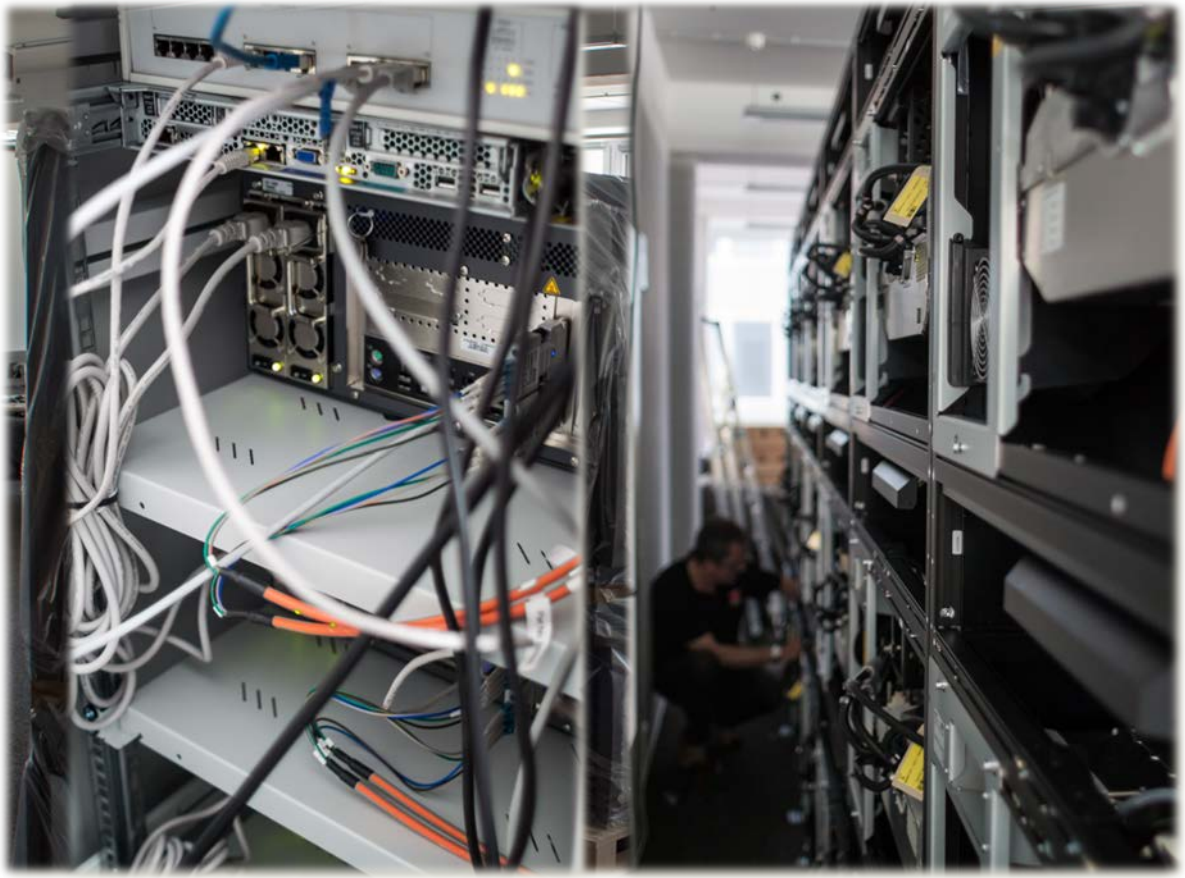
- The IDL is a **versatile platform for experiments in collaboration**
- Encourage and enhance **multidisciplinary collaboration**
  - Strive to work within **highly-integrated** interdisciplinarity
- Provide the technical environment necessary for **maximum flexibility,**
  - regarding **desk** and **seating arrangements**
  - regarding **network connectivity**
  - regarding sharing users‘ **displays**
  - regarding **face-to-face** and **team communication**
- Serve as a laboratory to investigate and improve collaboration methods
  - regarding **software integration**
  - regarding **knowledge management**
  - regarding **human factors**
  - regarding **collaboration methods**

The integrated design lab - prototype

The integrated design lab - prototype



The integrated design lab – next generation



Feedback and input devices

The integrated design lab – cockpit simulator

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- Introduction
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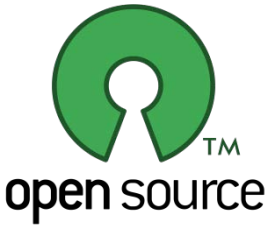
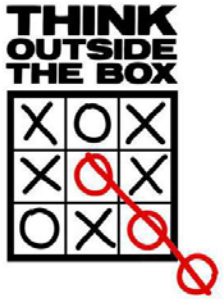
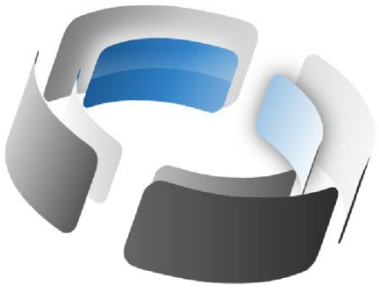
Conclusion





- Taking on the 3rd generation MDO with experiments in the IDL
- Join the CPACS community!
  - 3rd CPACS symposium at CEAS in Linköping 17-19 September 2013
- Find all open source software at DLR on http://software.dlr.de
- Come and visit our Integrated Design Laboratory
  - We'd like to share our experiences – become a partner
  - We'd like to offer our room and equipment for collaboration effort



INTEGRATED
DESIGN
LAB

DLR

Thank you very much!